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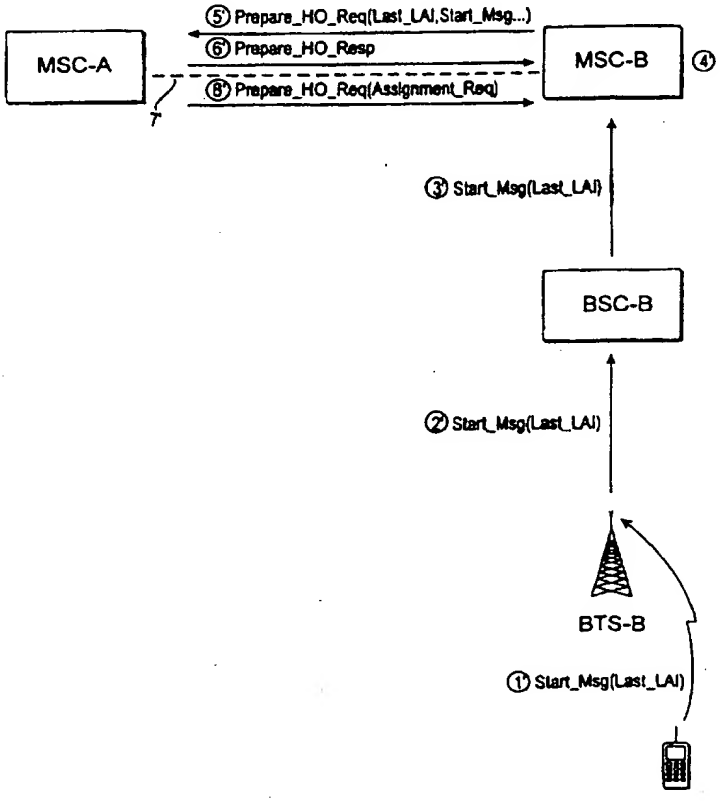
(54) Title: REVERSE INTER-MSC HANDOVER

(57) Abstract

The GSM system includes a protocol for re-establishing a lost call. A problem occurs if the call is lost after an inter-MSC (MSC-A, MSC-B) handover, resulting in that the system does not know into which MSC the subscriber data of a mobile station (MS) has been updated. If the MSC has changed during the call, and the MS is no longer able to contact the cell served by the original MSC-A, the call will be lost. In the method according to the invention, the MSC serving the location area of the mobile station detects a start message (1') transmitted by the mobile station and containing the Last Location Area Identifier of the mobile station. Based on the Last Location Area Identifier, the second center MSC-B, which detects the start message (1'), determines the first center MSC-A in whose area the call was started. Following this, the second center MSC-B may establish a connection to the first center MSC-A. At this stage, the centers (MSC-A and MSC-B) reverse roles and the method proceeds as in a conventional inter-MSC handover. The method of the invention for establishing a connection may also be applied to a satellite system that uses the GSM system network structure.



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Reverse inter-MSC handover

The present invention relates to mobile communication systems and particularly call re-establishment after call loss, as well as call establishment in satellite communication systems.

Figure 1 shows those parts of a cellular mobile communication system that are essential as far as the invention is concerned. Mobile Stations (MS) communicate with Base Transceiver Stations (BTSn) serving radio cells Cn. The base stations are coupled to Mobile Switching Centers (MSC) through Base Station Controllers (BSC). A subsystem under control of a BSC (the subsystem including base stations BTSn controlled by the BSC, and other elements of the mobile communication network that are not shown) is referred to as a Base Station Subsystem (BSS). The interface between the MSC and the BSS is referred to as an A interface.

The mobile switching center MSC handles the connecting of incoming and outgoing calls. It performs functions similar to those of an exchange of a public switched telephone network (PSTN). In addition to these, it also performs functions characteristic of mobile communications only, such as subscriber location management, jointly with the subscriber registers of the network. As subscriber registers, the GSM system at least includes a home location register HLR and a visitor location register VLR, not shown in Figure 1.

The GSM system is a system of the time division multiple access (TDMA) type, in which time-division communication takes place on the radio path in successive TDMA frames, each of which consists of several time slots. In each time slot, a short information packet is sent as a radio frequency burst which has a finite duration and which consists of a set of modulated bits. Apart from the

traffic channels transferring speech and data, the GSM system also uses control channels on which signalling between the base station and mobile subscriber stations is carried out.

Inter-MSC call traffic is transferred e.g. via the public switched telephone network (PSTN). In addition, signalling information is conveyed between the MSCs by using a so-called MAP connection (Mobile Application Part). The MAP protocol is specified in the ETSI GSM standard 09.02.

When the mobile station MS moves from one radio cell Cn to another, a handover (HO) is carried out in the system. It is possible to distinguish between handovers of many different types depending on which elements of the mobile communication system participate in the handover. Within the area of one BSC, the term used is Inter-BTS handover. Within the area of one MSC, the term used is Intra-MSC or Inter-BSC handover. When a mobile station moves from the area of a first mobile switching center MSC-A to the area of a second mobile switching center MSC-B, the term used is Inter-MSC handover. The MSC in whose area the call was started is referred to as an Anchor MSC.

Figure 2 shows signalling messages associated with a handover between the first center MSC-A and the second center MSC-B. It should, however, be noted that also other messages than those described are transmitted in a handover situation, but for reasons of clarity they are not shown here. 1: an MS transmits measurement results (Meas_Report) of the neighbouring cells to the serving base station system BSS-A. 2: the BSS-A determines the need for a handover to a cell in a new base station system BSS-B on the basis of e.g. radio path criteria. 3: the BSS-A transmits a handover request Handover_Required to the serving MSC-A. 4: the MSC-A transmits a handover request Prep_Handover_Req to the new MSC-B. 5: the MSC-B

transmits a Handover_Request to the BSS-B, or more specifically to its BSC, in which the new BSS-B is requested to provide the service requested. 6: if there are resources available, the BSS-B transmits a Handover_Request_Acknowledge message to the MSC-B. 7: the MSC-B transmits an acknowledgement message Prep_Handover_Resp to the serving center MSC-A. 8: the MSC-A transmits a Handover_Command to the serving BSS-A. 9: the BSS-A transmits a Handover_Command message to the MS. 10: the MS is now able to begin communicating in a new cell in the BSS-B. 11: the MS transmits an acknowledgement Handover_Complete to the BSS-B. 12: the BSS-B transmits a similar acknowledgement Handover_Complete to the MSC-B. 13: the MSC-B transmits, to the center MSC-A, an acknowledgement message Send_End_Signal_Req on the basis of which the MSC-A knows that the MS has switched over to the new base station system in the MSC-B. 14-15: finally, the resources allocated to the call in the old base station system BSS-A are released.

While roaming within the area of a mobile communication network, a mobile station MS may lose its connection to the base station BTS serving it. For situations of this kind, a so-called Call Re-establishment procedure has been defined in the GSM system. A description of such a procedure is offered e.g. in Mouly-Pautet "the GSM System for Mobile Communications", ISBN 2-9507190-0-7, pp. 412-415. The re-establishment according to the GSM system is twofold. The first part closely resembles random access procedure, with the mobile station having the leading role. The second part is controlled by the mobile communication network which restores the higher level connections of the network hierarchy.

A problem is encountered when a call is lost after an inter-MSC handover. Let us assume that a call is started in a cell served by the mobile switching center

MSC-A, and that a mobile station MS has roamed to the area under MSC-B during the call. A prior art mobile communication system is only able to carry out call re-establishment via the cell served by the original center MSC-A. If the mobile switching center has changed during the call and the MS is no longer able to contact the cell served by the original center MSC-A, the call will be lost. The subscribers find it annoying to have to start the call anew. It is especially inconvenient for the call to be lost during a data connection as computers, unlike people, are incapable of smoothly continuing from the point at which the call was lost. For example, a salesman transmitting an order to a sales office does not know whether the computer managed to book the order or not in case of call loss. The risk ensues that the same order is booked twice or that is not booked at all. Also, long data transfers, such as telefax transmissions, must in such a case usually be started afresh.

An analog drawback is evident in such satellite-based mobile communication systems which use a network structure based on the GSM system. Geosynchronous satellites orbit the earth, staying permanently at the same location in relation to the earth. Problems related to such geosynchronous satellites include high transmitting power requirements, resulting from the great distance, and long propagation delays. As far as satellites having a lower orbit are concerned, one of the problems encountered is that the network hierarchy may change even in the middle of a call due to satellites corresponding to base stations orbiting the earth. A problem resembling the connection loss described above is met in such a satellite system already at the connection set-up stage. In the satellite system, the problem results from the "base stations" changing position. Signalling used by a mobile communication system built on earth can

therefore not be applied as such to satellite systems. The difference can be seen e.g. in that upon paging a mobile station, the Page_Response message may be returned from an area of a different MSC than the one to which the Page call was sent. However, it will below be shown that the solution according to the invention of the problem caused by the connection loss can be applied to establishing a connection in a satellite system.

It is therefore an object of the invention to develop a method by means of which the aforementioned problems resulting from the moving of the mobile station and/or base station (i.e. satellite) can be solved. In the case of the GSM system, this entails a method for re-establishing a lost call in case a mobile station has during the call roamed from a first MSC area to a second MSC area. In the case of a satellite system this entails set-up of a mobile-terminating or mobile-originating connection. Here, "connection" may equally well refer to an ordinary call, a short message or a supplementary service.

The objects of the invention are achieved by a method which is characterized by that which is set forth in the independent claims. The preferred embodiments are disclosed in the dependent claims.

The invention is based on the mobile switching center which serves the mobile station detecting a start message transmitted by the mobile station, such a message in the case of the exemplary GSM system being a Re-establishment Request. The start message includes a Last Location Area Identifier (Last_LAI) of the MS. On the basis of the last location area identifier, the second center MSC-B, which detects the start message, determines the first center MSC-A in whose area the call was started. Following this, the second center MSC-B may set up a connection to the first center MSC-A. At this stage, the

two centers MSC-A and MSC-B reverse roles, and the method proceeds as in the case of a conventional inter-MSC handover.

The method according to the invention provides the advantage that a larger portion of interrupted calls may be resumed without the above problems associated with call loss. The invention further provides a simple method by means of which signalling of a conventional mobile communication system, such as the GSM system, may be applied to satellite systems.

In the following, the invention will be described by means of its preferred embodiments, with reference to the attached drawings, in which

Figure 1 shows, from the point of view of the present invention, the essential parts of a conventional cellular mobile communication system;

Figure 2 shows messages used in the prior art inter-MSC handover; and

Figure 3 shows the messages used in association with call re-establishment according to the invention.

Referring to Figure 3, a case will be discussed in which a mobile station MS has started a call in the area of the first center, MSC-A, and during the call roamed to the area of the second center, MSC-B. (The steps associated with Figure 3 are provided with apostrophes to distinguish them from the steps associated with Figure 2). If the connection is lost, the MS transmits and the base station BTS-B detects, at step 1', a start message, which in association with the exemplary GSM system may be a Re-establishment Request. At step 2' the start message is forwarded to the base station controller BSC-B and at step 3' to the MSC-B. The start message contains the Last Location Area Identifier (Last_LAI) of the mobile station and an MS identifier which may be either an IMSI (International Mobile Subscriber Identity) or a TMSI

(Temporary Mobile Subscriber Identity). At step 4' the MSC-B learns on the basis of the Last_LAI that the LAI in question does not belong to the MSC-B area and establishes a connection to the center (MSC-A) to whose area the Last_LAI belongs. At step 5' the MSC-B transmits, to the MSC-A, a Prepare_handover Message which has as its parameter the start message transmitted by the mobile station. At step 6', the MSC-A transmits an acknowledgement message Prepare_Handover_Ack to the MSC-B.

As shown by the above, steps 4'-6' resemble preparation of a normal inter-MSC handover discussed in connection with Figure 2, but with the second center MSC-B initiating the handover and at first operating as the anchor MSC.

At step 7', the centers MSC-A and MSC-B reverse roles so that the MSC-B operates as the anchor MSC from that moment on. At step 8', the MSC-A transmits a Prepare_Handover message to the MSC-B, after which the operation continues from step 5 as in the conventional inter-MSC handover discussed above.

The MAP protocol between the MSCs does not have to be modified as it can even presently be used to transfer any A-interface messages between the MSCs. The functionality of the MSCs must be supplemented so that they detect the above situations related to steps 4'-6'. In this case the message indicates other functionality than a handover and the MSCs must therefore be able to link the incoming handover request to some existing transaction at the MSC or to link it to the user information in the VLR. If, for example, it is the MSC-A that manages to do this, it transmits an acknowledgement message Prepare_Handover_Ack to the MSC-B. After that, the MSC-A is in control of the signalling protocols, and if the connection requires traffic channels, their allocation is started from the MSC-A.

The method according to the invention for establishing a connection may also be applied in such a satellite system which uses the GSM system network structure, whereby the base stations BTS of Figure 2 would correspond to satellites, which are not shown. In the case of a mobile-terminating connection (such as a call, short message or supplementary service) the system does not know in which satellite's area the mobile station should be paged, and so the mobile station will be paged in the areas of all the satellites. When the mobile station responds to the paging, it may send a similar message as the one described in association with Figure 3. In consequence, the system is able to restrict the connection to the satellite in whose area the mobile station responds to the paging. Correspondingly, at the beginning of a mobile-originating call, the MS may signal its location to the system in the manner described above.

The invention has been described by way of example in connection with the GSM system or a satellite system based on the GSM system. It is obvious for a person skilled in the art that the invention is applicable to other mobile communication systems as well. This means that, regarding the call set-up message and messages controlling the handover, the messages used in the system in question must be employed.

The invention and its embodiments are therefore not restricted to the examples above but they may vary within the scope of the claims.

Claims

1. A method for establishing a connection between a mobile station (MS) and a mobile communication system comprising at least a first mobile switching center (MSC-A) and a second mobile switching center (MSC-B), the mobile station (MS) in the method transmitting a start message (1'), characterized by the method further comprising the steps of:

- detecting, on the basis of the start message (1'), that the mobile station is located in the area of the second center (MSC-B);

- initiating handover from the second center (MSC-B) to the first center (MSC-A) so that the second center (MSC-B) at first functions as an anchor MSC; and

- reversing the functions of the centers (MSC-A and MSC-B) so that after the reverse the first center (MSC-A) functions as the anchor center.

2. A method as claimed in claim 1, characterized in that the start message (1') transmitted by the mobile station contains a last location area identifier (Last_LAI) of the mobile station (MS).

3. A method as claimed in claim 1 or 2, characterized in that the start message (1') transmitted by the mobile station (MS) is a Re-establishment_Request, and that the mobile station (MS) is, on the basis of the last location area identifier (Last_LAI) transmitted by the mobile station (MS), found to be located in the area of a different center (MSC-B) than the center (MSC-A) in whose area the connection was started.

4. A method as claimed in claim 1 or 2 for establishing a mobile-terminating connection in a satellite communication system, characterized in that the start message (1') transmitted by the mobile

station is preceded by paging of the mobile station (MS), initiated by the first center (MSC-A); and that the mobile station (MS) responds to the paging so that the response contains a start message (1').

5. A method as claimed in claim 1 or 2 for establishing a mobile-originating connection in a satellite communication system, c h a r a c t e r i z e d in that the mobile station (MS) transmits a start message (1') at the beginning of connection establishment.

Fig. 1

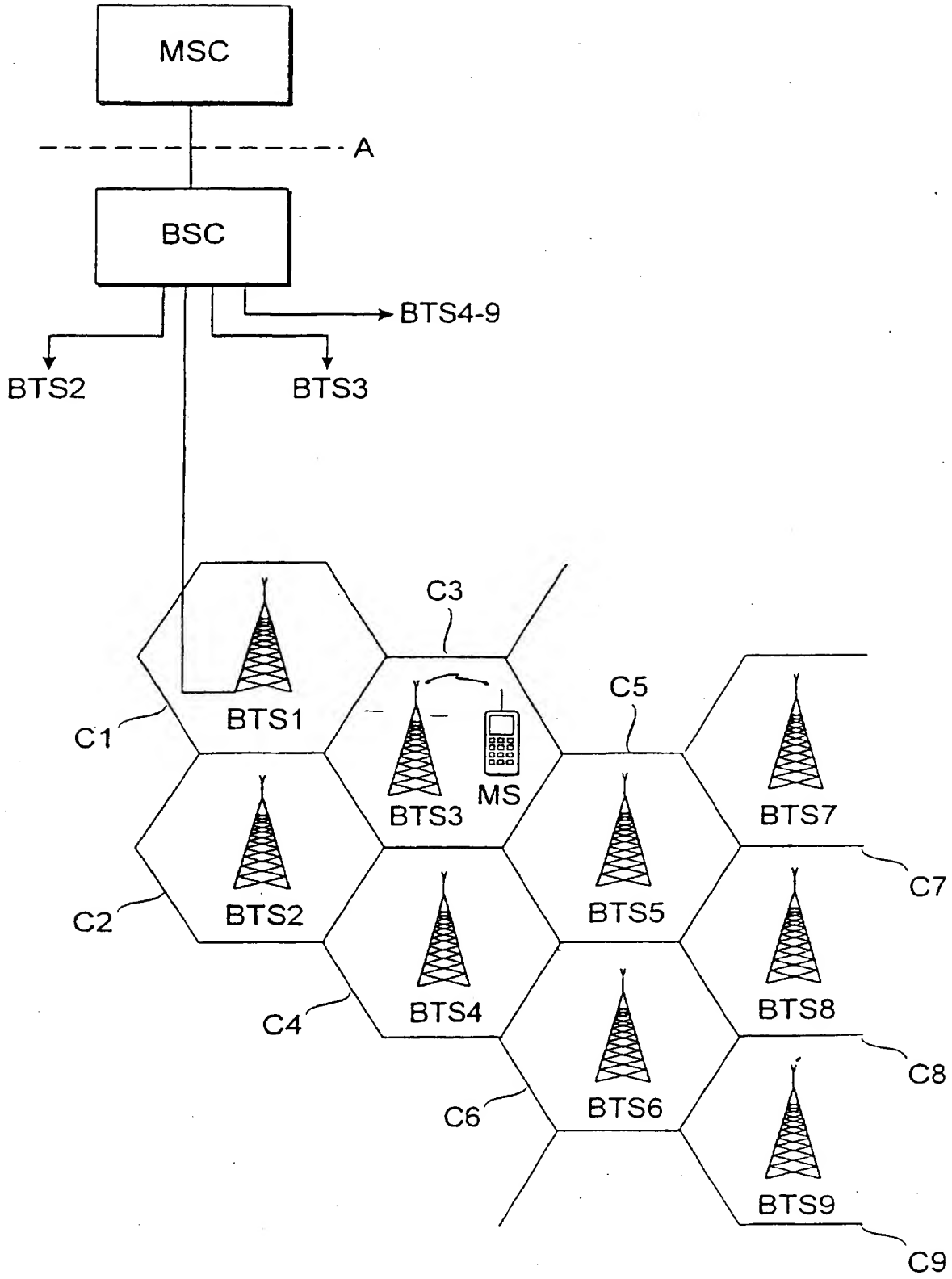


Fig. 2

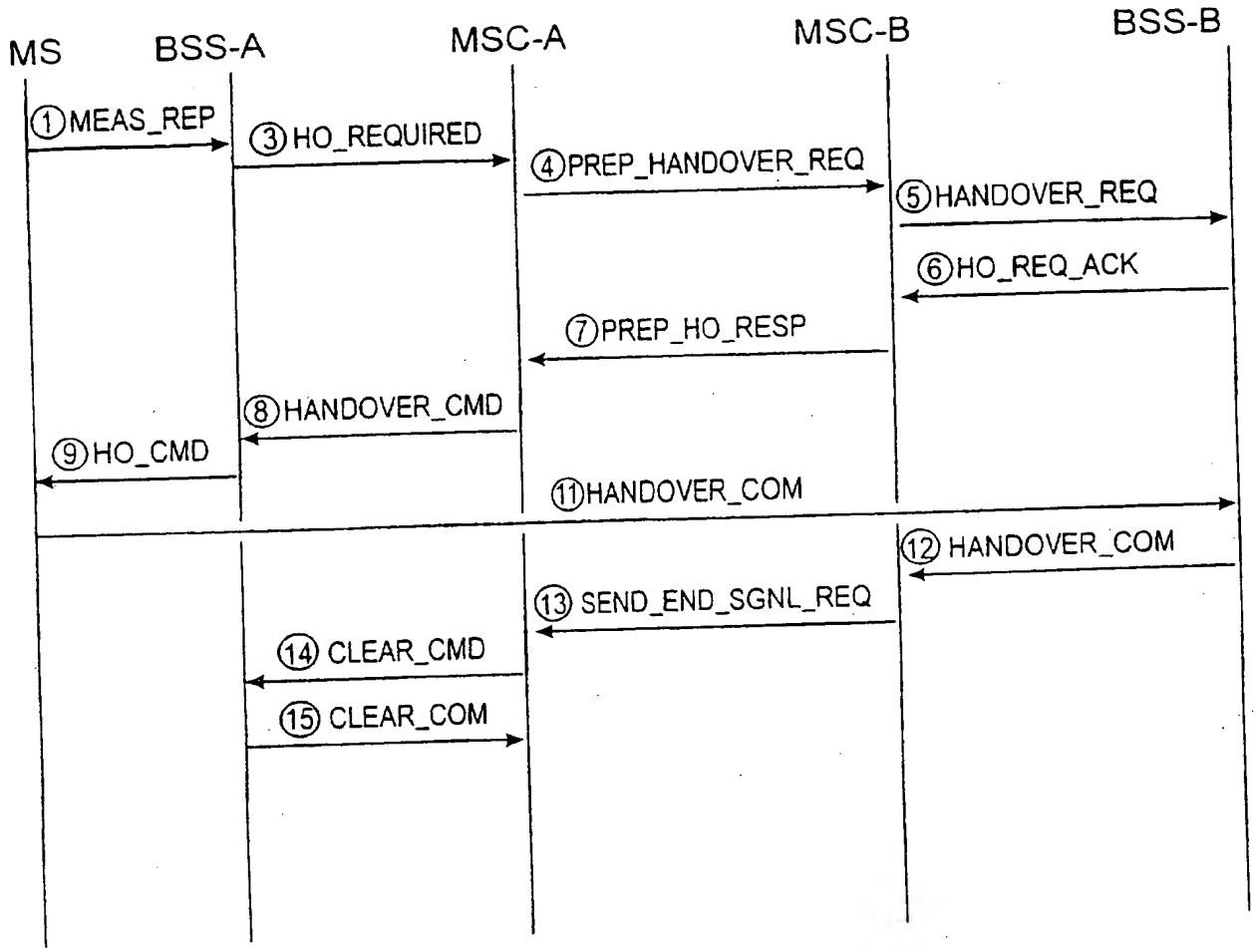
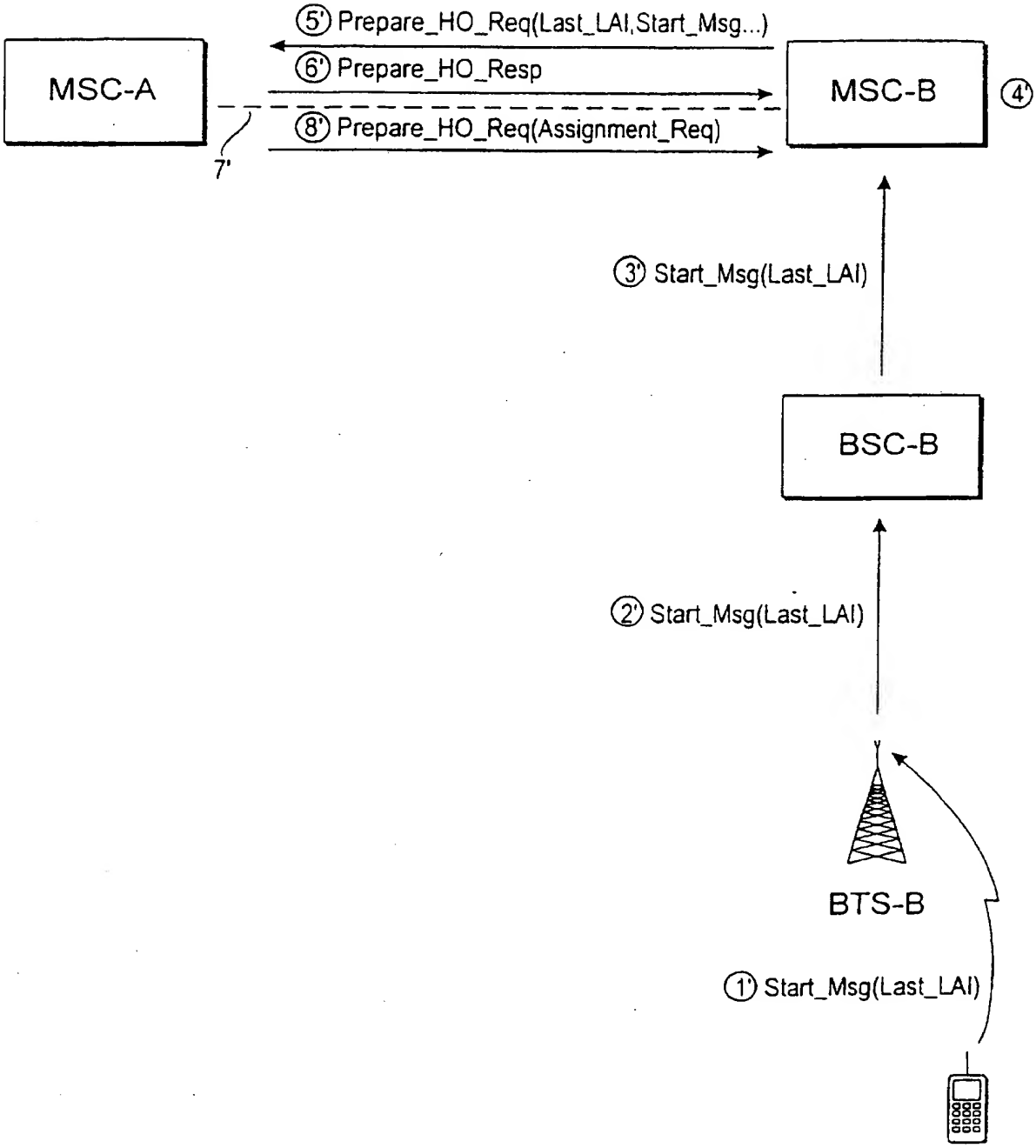

MS
BSS-A
MSC-A
MSC-B
BSS-B
①MEAS_REP
③HO_REQUIRED
④PREP_HANDOVER_REQ
⑤HANDOVER_REQ
⑥HO_REQ_ACK
⑦PREP_HO_RESP
⑧HANDOVER_CMD
⑨HO_CMD
⑪HANDOVER_COM
⑫ HANDOVER_COM
⑬ SEND_END_SGNL_REQ
⑭ CLEAR_CMD
⑮ CLEAR_COM

Fig. 3


⑤' Prepare_HO_Req(Last_LAI,Start_Msg...)
⑥' Prepare_HO_Resp
⑧' Prepare_HO_Req(Assignment_Req)
MSC-A
MSC-B
④'
7'
③' Start_Msg(Last_LAI)
BSC-B
②' Start_Msg(Last_LAI)
BTS-B
①' Start_Msg(Last_LAI)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 96/00667

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/38
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	The GSM System for Mobile Communications, ISBN: 2-9507190-0-7, Volume, 1992, Michel Mouly, Marie-Bernadette Pautet, "." page 311 - page 312	1
X	page 425; page 442 - page 444	2
X	page 378, table 6.5	4,5

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☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 June 1997	13.06.1997
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Peter Hedman Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.: 3
because they relate to subject matter not required to be searched by this Authority, namely:

Claim 1 gives the impression that the connection was started in MSC-B while in claim 3 it is stated that the connection was started in MSC-A

2. [ ] Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.